When at any station there was no record for some individual month, recourse was had to the records at near-by stations to approximate the lacking figures. For each such near-by control station the relation of the particular month's rainfall to that of the station's average annual rainfall was then ascertained. The 14-year period only was taken into account in estimating this relation. According to proximity or to similarity of topographic and orographic features, the several approximations thus obtained always expressed in per cent of normal annual rain (in this case the 14-year average), were weighted and were then used to establish the missing record expressed in percentage of the annual normal. This percentage applied to the station normal thereupon determined the desired amount in inches.

At some stations the record covered only a part of the 14-year period. In each such case the incomplete record was compared with the records for corresponding periods at such near-by stations as had complete records. The relation established by this comparison was accepted as the relation between the normal rain at the particular station in question and the normal rain at the control station. If several control stations were brought into consideration the several individual results were weighted, as explained, not by methods of least squares, but according to personal judgment, and the result was accepted with confidence.

It is to be noted, however, that the relation between the amounts of rain at near-by stations is much more likely to be fairly constant in California where the rain producing cyclones are generally of vast extent than would be expected where much rain falls during storms which cover only small areas.

Any refinement of calculation to give better results than can be obtained by the foregoing simple method is never warranted. This will appear when it is considered that the best that can be done is to secure an approximation. The records of the past are, moreover, generally required to serve only as a basis for a prediction of what may be expected to happen in the future. There is, furthermore, always so much uncertainty in the premises that no intricacy of calculation can give any more dependable results than the simple comparison above described.

TESTS OF RAINFALL-INTERPOLATION METHODS

ERIC R. MILLER

[Weather Bureau, Madison, Wis.]

The results of applying to some difficult cases the method of interpolation of rainfall data recommended in the MONTHLY WEATHER REVIEW, January, 1931, may be of interest to meteorologists on account of the light thrown on some unusual rainfall phenomena.

Figure 1 is a scatter diagram showing the correlation of the monthly rainfall in June for 33 years between 1895 and 1930 at Center Hall and State College, Pa., about 10 miles apart. The correlation coefficient for all cases is 0.52; excluding the cases of 1909, 1922, 1930, it is 0.84. Examination of the records shows that local downpours occurred at one or other of the stations in the excluded cases.

A similar diagram for June rainfall, 34 years between 1888 and 1930, for Titusville and Merritts Island, Fla., 17 miles apart, Figure 2, shows that the incoherence that affected only 3 of the 33 cases in Pennsylvania has here spread to the whole group. In spite of this, the wider range of values gives a higher coefficient, 0.61.

A third type of correlation, close for small values, dispersed for large, is shown in Figure 3, January rainfall, 20 years, 1897–1916, Campbell and Boulder Creek, Calif. About 15 miles apart, chosen on account of the large difference in their average January rainfalls, 4.07 and 14.65 inches, respectively.

Mr. C. E. Grunsky, the well-known engineer, has suggested comparison of the regression method of estimating rainfalls with a method that he devised in 1885 when, as assistant State engineer of California, it devolved upon him to prepare a rainfall map of the State. The basis of his method is the assumption that the ratio of rainfalls at neighboring stations is always the same as the ratio of the normals.

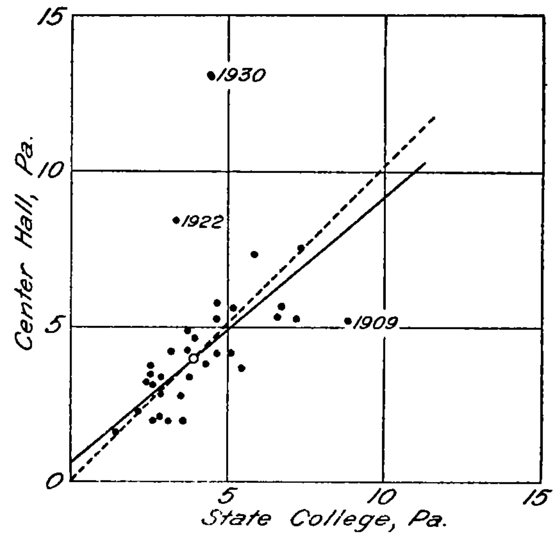

FIGURE 1.—Scatter diagram showing correlation of monthly total rainfall for June for 33 years

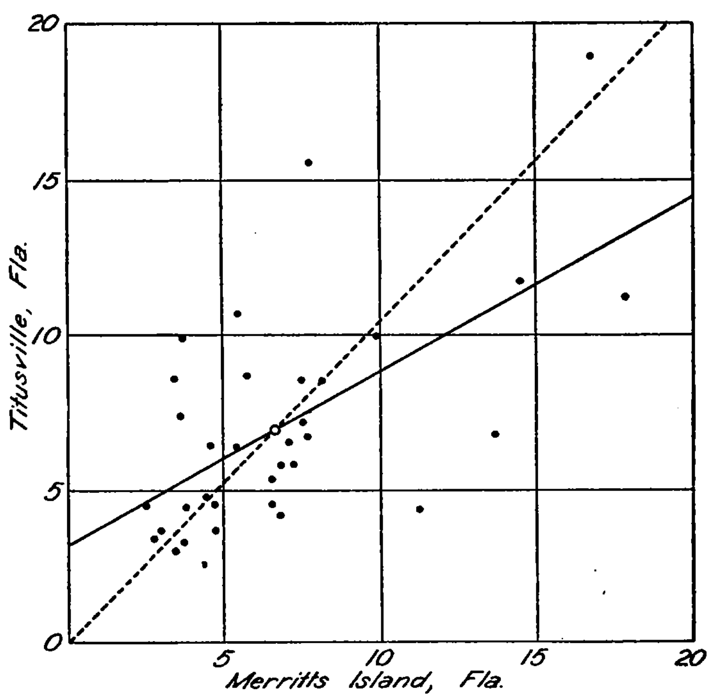

FIGURE 2.—Scatter diagram showing correlation of monthly total precipitation for June, 34 years

The regression equations minimize the sums of the squares of the deviations of the observed rainfalls from the computed. A suitable test of Mr. Grunsky's method consists in comparing the deviations of computed from observed rainfalls by the two methods.

The regression equations shown in the figures as continuous lines are:

$y=0.84\times0.54$ Center Hall on State College (1909, 1922, 1930 excluded).
$y=0.57\times3.03$ Titusville on Merritts Island.
$y=3.11\times1.99$ Boulder Creek on Campbell.

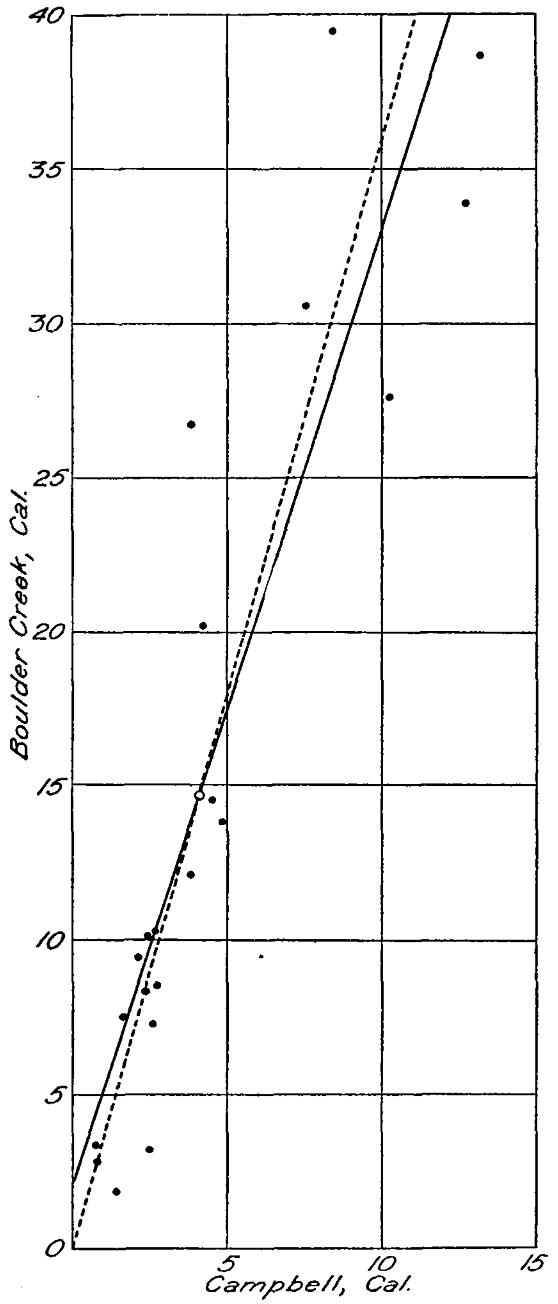

FIGURE 3.—Correlation of January rainfall, 20 years

where the amounts are in inches of rain per month.

The equations representing Mr. Grunsky's method are:

$$y=0.995\times$$
$$y=1.015\times$$
$$y=3.60\times$$

and these appear on the diagrams as dotted lines.

The results of the comparison are as follows:

	Sum of squares of deviations	Standard deviation	Probable error	Mean deviation	Maximum deviation
Center Hall:					
Regression	22.3470	0.86	0.59	0.75	1.85
Normals	29.0337	.97	.67	.77	1.88
Difference	6.6867	.11	.08	.02	.03
Titusville:					
Regression	316.3134	3.05	2.08	2.17	8.14
Normals	329.1524	3.11	2.13	2.39	7.79
Difference	12.8390	.06	.05	.22	−.35
Boulder Creek:					
Regression	527.7698	5.14	3.55	3.80	12.53
Normals	577.5369	5.37	3.72	3.91	12.60
Difference	49.7671	.23	.17	.11	.07

These results indicate that Mr. Grunsky's method is satisfactory for practical purposes, with the advantage of eliminating a great deal of arithmetical work. The normals should be based on simultaneous data.

The preparation of a scatter diagram is not very laborious, and affords valuable information about the closeness of correlation.

HIGH FLIGHTS OF SOUNDING BALLOONS [1]

By E. FRANKENBERGER

[Deutsche Seewarte Hamburg]

The author expresses the fact that most of our knowledge of the composition of the stratosphere is gained by indirect methods, and that it would be valuable if air-soundings, with direct measurements, were made to heights of over 30 km.

In the spring of 1929 the meteorological experimental bureau of the Deutsche Seewarte undertook to solve the problem of getting measurements at high altitudes by systematic sounding balloon flights. Mathematical calculations of the forces of expansion in partially elastic balloons were made, and by research the elastic qualities of balloon rubber and the most favorable amount of gas for sounding balloons were determined. As a result, a sounding balloon on November 2, 1929, reached a height of 35 km.

The question of the dependence of thermometer lag on the rate of ascent is taken up and also the problem of ventilation. The author says that the condition for attaining the greatest altitude is that the balloon rise until is reaches its floating level and then burst. To accomplish this it is stated, they must be inflated so that they rise slowly in the lower levels and that this slow vertical motion (180 to 240 m. per minute) gives poor ventilation. Thus the true temperatures must be calculated from the indicated temperatures by the use of thermometer lag factors. Investigations into the dependence of thermometer lag on air densities and ventilation are in progress for the tropospheric air densities and are under consideration for the small air densities of the stratosphere.

Five balloons 2,500 mm. (98 inches) in diameter were specially prepared for high flights during the international

[1] Analen der Hydrographie und Maritimen Mwteorologie, Jan., 1931, pp. 20-22.